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VARIATION IN THE POSITION OF THE ADDUCTOR MUSCLES OF ANADONTA GRANDIS SAY.

ELLIOT R. DOWNING.

THROUGH the kindness of Mr. Frank C. Baker, curator of the Chicago Academy of Science, I have had the privilege of examining and measuring a number of exceptionally perfect shells of *Anadonta grandis* Say. These shells were taken in August, 1897, from "South Pond," Lincoln Park, Chicago, where they were closely associated as a colony. As the pond was thoroughly cleaned four years previously, the age of the oldest shells is definitely known. Not only do the annual limits of growth show, but internally the muscle scars and the paths of migration are very distinct (see figures).

During part of the year shell growth occurs rapidly and muscle migration is also rapid ; again, growth nearly ceases, and the narrow dark band is deposited. During this slow growth the muscle is about stationary, and then the very distinct scar is formed.

The questions which I wished to settle were :

1. Does the muscle in its migration move at a rate proportional to shell growth, so that the muscle retains a fixed relation to the shell's proportions ?

2. If not, how does it vary ?

I chose for this study the ratio,

$$\frac{\text{distance from the umbo to the muscle}}{\text{distance from the umbo to the shell margin}}.$$

In all the shells the separation of the anterior adductor from the anterior retractor is marked by a very distinct ridge, making a fine line which lies in the path of migration. The distance measured along this line on the curve of the shell, from the umbo to the point where the outer boundary of the anterior adductor scar cuts the line, made the first term of the ratio (see x_1, x_2, etc., Figs. 1 and 3). The second term was the distance from the umbo along this line produced to its intersection with the shell margin. A similar ridge is formed at the anterior margin of the posterior adductor. The first term of the ratio for the posterior adductor is the distance from the umbo to the point where this line is tangent to the adductor scar (y_1, y_2, etc., Figs. 1 and 3). The second term is the distance measured

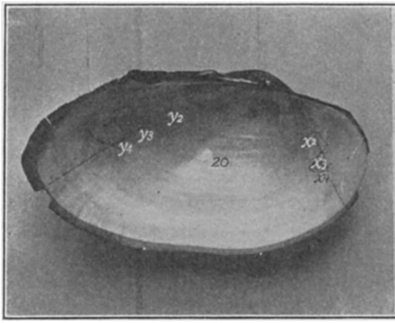

FIG. 1.

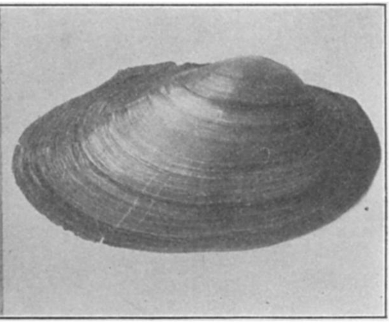

FIG. 2.

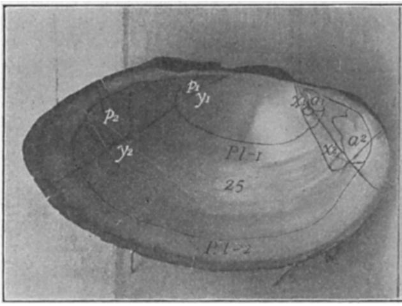

FIG. 3.

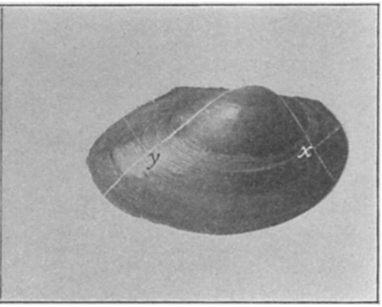

FIG. 4.

FIG. 1. — Interior of a four-year-old shell, impressions emphasized by ink lines.

FIG. 2. — Exterior of a four-year-old shell.

FIG. 3. — Interior of a two-year-old shell.

FIG. 4. — Exterior of a two-year-old shell.

a_1, a_2, anterior adductor scars; p_1, p_2, posterior adductor scars; x_1, x_2, x_3, etc., points on ridge between anterior adductor and anterior retractor, fixed by its intersection with the adductor's outer margin; y_1, y_2, etc., points on ridge at anterior limit of posterior muscle impression at which adductor margin is tangent to the ridge.

along this line produced, from the umbo to its point of intersection with the shell margin. The proportions then are:

$$\frac{\text{umbo to anterior adductor}}{\text{umbo to anterior margin}}, \text{ and } \frac{\text{umbo to posterior adductor}}{\text{umbo to posterior margin}}.$$

The umbo in this species comes to a sharp point, which was in no case eroded. It afforded a definite point from which to measure. The measurements were made along the outer surface of the shell. The shells were thin and quite transparent, so that lines and points marked on the inside were readily traced by a soft pencil on the outside by holding the shell to a strong light (Fig. 4). Most of the shells were four years old, a few three, and some two. (The exteriors of two- and four-year-old shells are given in the figures.) Measurements were made and the ratios calculated for two hundred and seventy anterior adductor scars, and for the same number of posterior adductor scars.

In order to plot a curve for these ratios, the following classes were taken for the anterior adductor:

CLASSES.	FREQUENCIES.
.585 – .604	1
.605 – .624	8
.625 – .644	27
.645 – .664	38
.665 – .684	90
.685 – .704	64
.705 – .724	27
.725 – .744	13
.745 – .764	2
	270

The classes for the ratios of the posterior adductor are:

CLASSES.	FREQUENCIES.
.575 – .594	1
.595 – .614	8
.615 – .634	25
.635 – .654	71
.655 – .674	96
.675 – .694	45
.695 – .714	19
.715 – .734	4
.735 – .754	1
	270

Different limits for the classes were selected in the seriation so as to give in each case the most nearly normal distribution of frequencies.

Laying off the frequency polygon by the method of rectangles gives Figs. 5 and 6, both curves of Type 4. The essential data for these curves are:

	ANTERIOR.	POSTERIOR.
A	.6783	.6613
v_1	.0033	–.0037
u_3	–.00000138	–.00000297
B_1	.00005	.041
B_2	74.47	1388.8
F	–142.94	–2771.47
α (skewness)	–.00028	–.022
σ (index of variability)	.0287 ±.00083	.0254 ±.00073

Discussion of results.

1. *The distance of the adductor muscle from the umbo,* measured along the line of migration, *varies considerably in its relation to the distance to the shell margin,* measured along the same line produced. The extreme ratios are .591 and .754. The measurements in the latter case are $\frac{49 \text{ mm.}}{65 \text{ mm.}}$. To produce the former proportion we should have to have 37.3 mm. instead of 49 mm., — a change of 11.7 mm., or nearly ¼ of the total measurements.

2. *While the range of variation* then *is comparatively large, yet the frequencies are well concentrated* at or near the mode. *In 93 per cent of the cases the position of the muscle would not vary 3 mm., in either direction from the mean position.*

3. *Roughly speaking,* we may say that *the muscle is situated two-thirds of the way from the umbo to the margin.* Accurately, the mean ratios are .6757 for the anterior muscle and .6608 for the posterior.

4. It was thought at the outset of the investigation that the results might indicate a difference in the rate of migration of the adductor muscles, one approaching the shell margin at a more rapid rate than the other. The negative skewness of both

curves, however, would indicate a tendency toward smaller ratios ; that is, a decrease in the relative distances from the umbo to the muscle impression. This may mean that the muscles migrate constantly less rapidly than the margins grow. Since the skewness is least in the anterior adductor curve, the anterior adductor tends to move toward the margin at a more rapid rate than the posterior, although there is a tendency in both to lag behind the rate of growth of the shell margin. The greater variability of the anterior muscle position would indicate that it is the muscle most concerned in the evolutionary process. However, variability and skewness are both so slight that the above conclusions must be tentative until

Fig. 5.

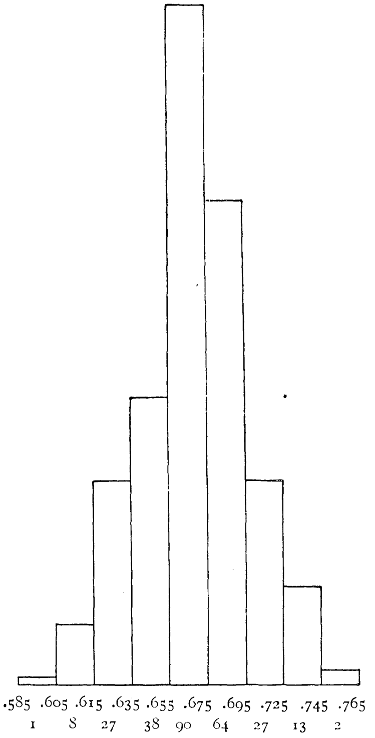

Fig. 6.

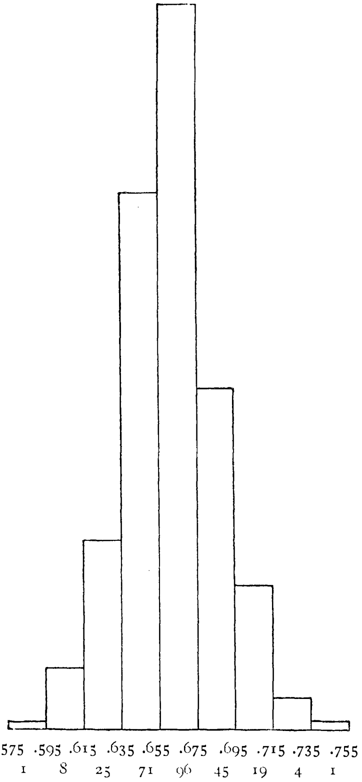

Fig. 5. — Frequency polygons for anterior adductor ratios.
Fig. 6. — Frequency polygons for posterior adductor ratios.

further evidence can be adduced. We seem to have in this form a species that is stable, rather than one that is in process of rapid evolution.

I am indebted to Dr. C. B. Davenport for valuable suggestions and assistance in carrying on this study.

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